

Claims

1. A diaphragm valve comprising:
a valve body defining a valve passage having an inlet and an outlet;
a diaphragm having first and second sides and positioned such that the first side is proximal to the valve passage, the diaphragm operable, in response to an applied actuation force, to transition between a closed position blocking the valve passage and an open position wherein the valve passage is at least partially open;
an enclosed space adjacent the second side of the diaphragm; and
a vent passage communicating with the enclosed space to vent the enclosed space, thereby facilitating transitioning of the diaphragm between the open and closed positions.
2. In combination with a diaphragm valve according to claim 1, means operatively coupled to the vent passage for reducing fluid pressure in the enclosed space.
3. In combination with a diaphragm valve according to claim 1, a pump operatively coupled to the vent passage.
4. A diaphragm valve and pump according to claim 3 wherein the pump is operable to draw a vacuum in the enclosed space.
5. A diaphragm valve and pump according to claim 3 wherein the pump is operable to draw a vacuum of between approximately 0.1 mbar and approximately 20 mbar within the enclosed space.
6. A diaphragm valve according to claim 1 further comprising an actuator coupled to the diaphragm for applying an actuation force to the diaphragm for transitioning the diaphragm between the open position and the closed position.
7. A diaphragm valve according to claim 1 further comprising a spring for biasing the diaphragm toward one of the open and closed positions.
8. A diaphragm valve according to claim 7 wherein the spring biases the diaphragm toward the closed position, and further comprising an actuator operably coupled to the diaphragm for transitioning the diaphragm from the closed position to the open position.
9. A diaphragm valve according to claim 7 wherein the spring biases the diaphragm toward the open position, and further comprising an actuator operably

coupled to the diaphragm for transitioning the diaphragm from the open position to the closed position.

10. A diaphragm valve according to claim 6 further comprising:
a heating body positioned proximal to the second side of the diaphragm to maintain an operating temperature of the diaphragm; and
a thermally resistive member interposed between the valve passage and the actuator.
11. A diaphragm valve according to claim 10 wherein the actuator includes a solenoid.
12. A diaphragm valve according to claim 10 wherein the venting passage passes through the heating body.
13. A diaphragm valve according to claim 1 wherein the venting passage passes through the valve body.
14. A diaphragm valve according to claim 6 wherein the actuator includes a movable plunger, a stop positioned to limit the movement of the plunger, and a blocking member interposed between the plunger and the stop.
15. A diaphragm valve according to claim 14 further comprising a spring that biases the plunger away from the stop, and wherein the actuator comprises a solenoid, the plunger is magnetically attracted toward the stop when an electric current is applied to the solenoid, and the blocking member comprises a nonmagnetic material to thereby reduce a release time necessary after removal of the electric current from the solenoid until the spring moves the plunger.
16. A diaphragm valve according to claim 1 wherein the diaphragm is comprised of a plastic material.
17. A diaphragm valve according to claim 1 wherein the diaphragm is comprised of an elastomeric material.
18. A precursor material delivery system including a diaphragm valve according to claim 1.
19. A precursor material delivery system including a diaphragm valve according to claim 11.
20. An ALD reactor including a diaphragm valve and means for generating suction according to claim 2.
21. An ALD reactor including a diaphragm valve according to claim 15.

22. A diaphragm valve system comprising:
a body means defining a valve passage having an inlet and an outlet;
a diaphragm having first and second sides and positioned such that the first side is proximal to the valve passage;
means for defining an enclosed space adjacent the second side of the diaphragm; and
means for reducing a fluid pressure in the enclosed space.

23. A diaphragm valve system according to claim 22 further comprising means for actuating the diaphragm.

24. A diaphragm valve system according to claim 22 further comprising means for heating a medium in the valve passage.

25. A diaphragm valve system according to claim 23 further comprising means for attenuating heat transfer between the valve passage and the means for actuating.

26. A diaphragm valve system according to claim 22 for use in an ALD reactor.

27. A diaphragm valve system according to claim 25 for use in an ALD reactor.

28. A method of transitioning a diaphragm between a closed position and an open position in a diaphragm valve having a valve body, the valve body defining a valve passage having an inlet and an outlet, the diaphragm having a first side proximal to the valve passage and a second side adjacent an enclosed space, the diaphragm further being operable in response to an applied actuation force to flex between the closed position blocking the valve passage and the open position wherein the valve passage is at least partially open to allow flow through the valve passage, the method comprising:

providing a venting passage in communication with the enclosed space; and
venting the enclosed space via the venting passage to prevent buildup of pressure behind the diaphragm, thereby facilitating transitioning the diaphragm between the closed position and the open position.

29. A method according to claim 28 further comprising applying suction to the venting passage.

30. A method according to claim 29 further comprising applying an actuation force to the diaphragm.